

就学前期小児に対するFogs'test適用の試み

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Practical Use of the Fogs'test in the Preschool Children

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Summary

Forty-five normal right-handed children aged between 4 and 6 years undertook the Fogs'test by which associated movements were released. As results, it was found to be possible for the preschoolers to accomplish the test. Among four types of feet postures included in the Fogs'test, the everted feet posture was the most difficult to perform, followed by the inverted, the heels and the toes.

Furthermore, female showed the lower score on the test than did male, indicating, at least, that, even in preschool-aged children, female performed more skillful compared with male in the same age range.

KEY WORDS Fogs'test, associated movement, neurological minor signs

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INTRODUCTION

Associated movements have been documented as the involuntary overflow phenomenon during an intended movement. Since the more mature neuromotor system related to the cerebral inhibition, the less associated movements observed during childhood, they were described as a reliable measure of developmental age in normal children (WOLFF *et al.*)¹⁾. In addition to such a significance of developmental examination in normal children, associated movements also have a diagnostic significance of the children who are suspected of brain damage, that is, minimal brain dysfunction (MBD), learning disorders (LD), hyperactivity or of a developmental delay, if they persist beyond the criterion age or show the specific pattern of their appearances (eg; prominent asymmetries or unusual magnitude valued for chronological age). This clinical significance of associated movements has been called neurological

minor signs (NMS)^{1~7)}. Associated movements indicating NMS may also appear in adults with congenital or acquired lesions of the central nervous system (CNS) as well as in children⁸⁾.

In spite of a lot of investigations on associated movements, however, up to the present, it has been short of the distinct common understanding of associated movements among researchers, particularly because each researcher was likely to use his own methodology (test) by which associated movements are produced. SZATMARI *et al.*⁹⁾ developed the Fogs'test which had been originally described by Fog and Fog¹⁰⁾ and systematically demonstrated that children with any kind of behavior problems had more difficulty with the test than those without. We have been applying the the Fogs'test to normal children or children with epilepsy at different ages or handednesses not only to confirm the validity of the Fogs'test, but to define the normal range of the magnitude of associated movements¹¹⁾. The purposes of this study were 1) to see whether the preschool aged children could accomplish the Fogs'test,

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2) to define the normal range on associated movements against which to compare those of children referred for neurological examination, 3) to check on whether there was sex difference in the results of the Fogs'test at the preschool age (4 to 6 years old).

METHOD

Subject

Forty-eight children participated in this study were all attending the same day nursery in the urban area of Osaka city. Although IQ test was not performed, no children showed any developmental abnormalities on the original developmental records reported by nursery mothers every months after birth. Handedness was verified by the Crovitz & Zener's hand dominance test¹²⁾ which had been partly modified by us to fit the Japanese children¹³⁾¹⁴⁾ Virtually, 45 children (male 27, female 18) identified to right-handedness undertook the Fogs'test.

Table 1 shows the mean age and SD (months) of our subjects. There was no statistically significant difference between the mean age of male and that of female.

Table 1. The mean age and SD of subjects (months)

Male (27)	61.0 ± 5.5
Female (18)	62.2 ± 5.7

Procedure

Fogs'test was performed at the day nursery from May to August in 1988. Children wore active light uniform with barefoot. Each child was asked to walk about 3m toward the examiner with the handy-typed video-tape recorder (SONY Hi-Band Betamovie BMC-600) and return to the starting point in the following four types of postures; 1) on their heels, 2) on their toes, 3) with feet inverted, 4) with feet everted. Before each walking, the examiner gave instructions and simultaneously demonstrated to each child the required legs or feet postures, and during walking, children were encouraged. The frontal, lateral, and back views of each child's walking were video-taped.

Analysis

Associated movements (synkinesis) induced by the

Fogs'test appeared mainly on the upper extremities involuntarily which postures look like those of their lower extremities. By means of the video analysis, we scored on six categories according to SZATMARI et al⁹⁾ as follows.

- (1) grade of difficulties in assuming each feet posture (0: no difficulty, 1: slight, 2: remarked, 3: unable to assume)
- (2) grade of difficulties in maintaining the walking balance (0: none, 1: slight, 2: remarked)
- (3) degree of tilting body forward, back or to either side (0: none, 1: slight, 2: remarked)
- (4) degree between upper extremity and trunk (0: none or minimal, 1: less than 20°, 2: more than 20° for each arm)
- (5) degree of hand movement (0: none or minimal, 1: either wrist or finger movements, 2: both wrist and finger movements, for each arm)
- (6) degree of flexion of arm at elbow (0: none or minimal, 1: less than 45°, 2: greater than 45°, for each arm)

Last three categories; No. 4, 5, 6 were scored on the right and left arms respectively. The maximum score for each posture was 19, then, the maximum total score for the whole four postures was 76 (19×4).

RESULT

All subjects except for one boy were able to assume each feet posture. This 4-year-old boy failed to accomplish the everted feet posture, so he was excluded from the analysis.

Generally, each feet posture released its own unique posture or movements on the upper-extremities, that is, toe-walking release abduction and extension of arms and fingers; heel-walking released finger flexion and wrist dorsiflexion; inversion released abduction of the arm and flexion of the arm, elbow, wrist and fingers; and eversion caused the arms to be rotated, extended backward, and the fingers to be extended and abducted (see Fig. 1 to 4), as SZATMARI et al⁹⁾ previously had described, although the mean age of subjects in this paper was lower than that of them.

The mean score on the Fogs'test (the normal range of associated movements)

Table 2 presents the mean score and SD on the Fogs'test. In the total score, male score (32.1, range;



Fig. 1 Walking on the heels
(see her dorsiflexed wrists)



Fig. 2 Walking on the toes



Fig. 3 Walking with feet inverted
(see his flexed wrists and fingers)



Fig. 4 Walking with feet everted
(see his rotated arms and finger postures)

Table 2. The mean score and SD on the Fogs'test

	Total	Heel	Toe	Inverted	Everted
Male (26)	32.12±7.45	7.35±3.39	3.69±2.63	9.08±3.60	11.58±1.88
Female (18)	24.56±7.28	5.44±2.64	2.72±2.54	7.39±3.97	9.50±2.26

Total=total score, Heel=walking on the heels, Toe=walking on the toes Inverted=walking with feet inverted, Everted=walking with feet everted. There were significant differences in mean score between the sexes in Total, Heel, and Everted (p values=0.005, 0.05 and 0.005 respectively). The mean score on Everted was higher than on Inverted (male; $p<0.005$, female; NS), Inverted than Heel (male; $p<0.05$, female; NS), Heel than Toe (male; $p<0.005$, female; $p<0.005$).

13–45) was higher than female (24.6, range; 11–40) significantly ($p<0.005$). It means that, even in the early childhood (aged between 4 and 6 years), female performed the test more skillful and simultaneously showed less associated movements than did male.

When the Fogs'test was divided into 4 types of walking (feet posture) as above mentioned, two types of them; the eversion and the heel-walking showed significant ($p<0.005$, $p<0.05$ respectively) differences between the male score and the female.

Furthermore, in both sexes, among four types of feet postures, the eversion showed the highest score followed by the inversion, the heel-walking and the lowest score was shown on the toe-walking.

DISCUSSION

The reliability of scoring

In order to confirm the scoring reliability, the video analysis (scoring) was done again after two months (August) for 11 children who had been examined and scored in Jun. The correlation coefficient between the scores obtained on the first viewing of 11 children and those on the second viewing of them two months later was culculated. At this result, the correlation coefficient was good at $r=0.93$ ($p<0.0005$). It appears that the stability of the relative estimation of the magnitude of associated movements was maintained during two months.

On the other hand, however, a paired Test showed that the second scores were significantly ($p<0.005$) higher than the first. It means that the scoring criterion

perceived by the examiner might be unstable, that is, the second criterion might be more severe than the first. This finding indicates that more objective scoring device should be required.

Some findings obtained from the Fogs'test

At first, even in the preschool children (4 to 6 years), almost children could execute the test, although some of them showed a little difficulty in keeping on walking with a consistent feet posture. Only a 4-year-old boy could not accomplish one type of posture; the everted feet posture. SZATMARI et al⁹⁾, who examined the primary school children (aged between 7 and 11 years), investigated the relationship between the scores on their modified Fogs'test and behavior problem, cooperation, reading ability or school achievement. And then, SZATMARI⁹⁾ found that the higher score group in their Fogs'test showed more problems than the lower score group. This findings indicate that Fogs'test may be efficient to examine whether several behavioral or cognitive problems are due to neuro-developmental delay or minor brain damage in the school-aged children. Furthermore, WOLFF et al¹⁾ noted that the associated movements on the Fogs'test continuously decrease with increasing age from infancy through childhood. From these studies, the assumption that the Fogs'test at the preschool age paralleled to that at the school age may also provide the meaningful evidence of neuro-developmental delay or brain damage which may cause behavioral or cognitive problems could be deduced. Whereas, in contrast, it is also probable that the younger children are, the more sensitive to any other types of factors (behavioral or emotional etc.) than neuro-maturation itself, that is, the score on the Fogs'test in the preschool children is more likely to be influenced by such various inessential factors. If accepted this hypothesis, the Fogs'test in preschool-aged children (4 to 6 years old) would have less validity than in school-aged children. Thus, there are these two assumption opposed to each other. Though it is impossible to examine these assumption within the data from the present study, so far as we observed the tendency of appearance of associated movements in normal children, the behavioral factors (eg; distraction or inattentiveness) seemed to decrease the magnitude of the associated movements rather than increase it. Therefore, it is primarily important to make children perform with their maximum

effort which results in the maximum associated movement in order to keep a sufficient validity. Moreover, especially when clinical children are examined, the behavioral characteristics of each child needs to be recognized enough and to be reflected on the diagnosis.

Secondly, the score was more the eversion, the inversion, the heel-walking, and the toes in that order. This finding were consistent with those of WOLFF *et al.* It has been described in numerous studies that the more difficult to execute the examinations were, the more associated movement children showed^{2~7,15}. Therefore, as the value of the mean score could be thought to represent the degree of difficulty in assuming the feet postures or walking, it is concluded that the most difficult posture of the four types postures for children to try is the walking with feet everted. The mean score (10.5 of the maximum 19) on the eversion, nevertheless, indicates that the eversion is never too difficult for the preschool children and also may be the more suitable loading in order to evaluate the long-term changes of the magnitude of associated movements from the kindergarten through the primary school age, because, on the easier postures (on the heels or toes), almost children are certain to show little associated movement by the lower grade (1 or 2 grade) of the primary school.

Third, it is noteworthy that female obtained the higher mean score than male during the preschool period, indicating that, even in such an early period, indeed, female was able to perform the Fogs'test more skillfully than male in the same age range. This results would be unique, because few studies showed the sex differences in performance in the preschoolers, whereas in the school children, several studies noted such sex differences^{16~18}. Since the Fogs's test is one of the gross motor movement tests, it would be better to control such sex differences even in the studies on gross motor development during the preschool period. Furthermore, from this sex differences in performance, female superiority in neuromotor maturation during the preschool period (4 to 6 years) would be inferred. Nevertheless, because factors other than neuromotor maturation might affect the results in the present study, this inference needs to be examined by the more systematic studies.

In conclusion, it was revealed that preschoolers can perform the Fogs'test, and the results of this study

provided the normative data for the diagnosis of the clinical children. We think that together with the assessments of associated movements, the examinations of the different aspects of neurological functions (eg, cognitive or manipulative) in normal children or in children with epilepsy are also necessary.

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和文要約

神経学的検査の一種で随伴運動 (associated movement) を主な観察点とする Fogs' test を就学前期 (4 - 6 歳) の健常小児 45 名 (男 27 名, 女 18 名 全員右利き) に対して試行した。その結果, Fogs' test はこの年齢層でも検査可能であること, Fogs' test に含まれる 4 種の歩行形態の中で最も遂行困難であったのは外反歩行で, 次いで内反歩行, かかと歩行, 爪先歩行の順であることが明かになった。さらに, このような低年齢層にあっても男女差がみられ, 女子の方が男子に比べ, より遂行能力が高かった。